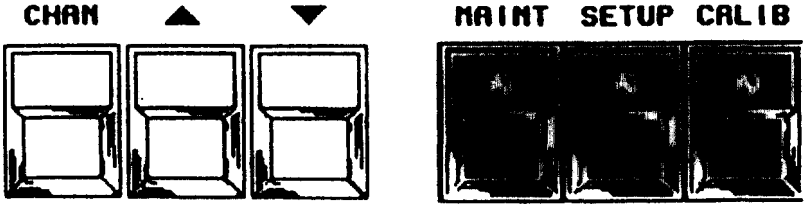


CHAN	
Normal mode:	Select channel for control and metering
Calibrate:	Select channel to calibrate
Setup:	Select status input to set polarity
▲	
Normal mode:	ON/RAISE for channel selected
Calibrate:	Increase reading for channel selected
Setup:	Invert polarity of status channel indicated by channel number
▼	
Normal mode:	OFF/LOWER for channel selected
Calibrate:	Decrease reading for channel selected
Setup:	Shift decimal point
MAINT	Control from Studio disabled when on
SETUP	Inverts status inputs and sets decimal point
CALIB	Enables calibration using ▲ and ▼ keys

figure 2-2.

Mode Selection

Each mode is entered by momentarily pressing the appropriate mode switch. Pressing the switch again will exit the mode. Setup and calibration are mutually exclusive modes, so pressing either of these switches will deselect the other.

Each mode of operation will be described in detail:

Normal Mode

In the normal mode, studio and transmitter units function identically but independently. That is, different channels may be selected by each unit for either metering or control purposes.

The system is in the normal mode when the maintenance, setup, and calibrate LED's are dark. Pressing the channel select advances to the next channel as indicated on the channel display. Channel eight advances to channel one. The display immediately indicates the value for the selected channel. Pressing the raise or lower switch asserts the appropriate output at the transmitter site for as long as the switch remains pressed. Rollover protection is provided to assure that both raise and lower cannot be activated at the same time.

Maintenance Mode

The maintenance mode is analogous to the "Remote/Local" switch on older remote control systems. In this mode, the studio may continue to select channels for metering but may not initiate any control functions. The LED on the maintenance switch at both the studio and the transmitter indicates that the system is in this mode.

The fail-safe output is forced on while in the maintenance mode, allowing normal local operation with or without a valid studio to transmitter control link.

Setup Mode

The setup mode may be entered only from the transmitter. This mode allows the decimal point location to be set for each metering channel and the status polarity to be set for each status input. Normal control and metering functions are operable from the studio during setup. Both studio and transmitter setup switches will light when the setup mode has been selected.

To set status polarity, enter the setup mode and select the metering channel that corresponds to the number of the status channel. Pressing the raise switch will invert the status from normally on to normally off or vice versa. Additional channels may be altered without leaving the setup mode. Changes are stored in non-volatile memory upon leaving the setup mode.

Note that the setup procedure is the only instance where the status number has any correlation with the indicated channel number.

To set the decimal point location for any channel, enter the setup mode and select the channel, then use the "lower" switch to rotate the decimal point into the desired position. The decimal point may be set to the right of any digit, allowing readings to be expressed in the appropriate units from X.XXX to XXXX. Additional channels may be altered without leaving the setup mode. Again, the changes are made permanent upon leaving the setup mode.

Calibrate Mode

The calibrate mode is also available only from the transmitter. Press the calibrate switch and select the desired channel. Calibrate switches on both units will light to indicate this mode.

Press the raise or lower switches until the displayed value corresponds to the actual meter reading being sampled. Pressing either switch briefly causes a one digit change in the indicated direction. Holding the switch causes the value to change with increasing speed. It takes approximately 20 seconds to go from zero to 9999.

Calibration will not function if the input sample is below 250 millivolts or above about 4.5 volts. The larger the sample voltage, the more accurate and precise the displayed value will be. Where possible, select a nominal input voltage near four volts. A small input voltage calibrated to a large value will appear to jump due to the one

in 4096 resolution of the A/D converter but will still be within the rated accuracy.

A frequency monitor may be sampled and calibrated to read in 0.1 Hz increments (AM carrier or FM pilot) or 0.1 kHz increments (FM Carrier) by setting the decimal point to the XXX.X position.

Link Alarms

The links from the studio to transmitter and from transmitter to studio are constantly monitored for accurate data transmission. Minor disturbances and "hits" on the circuit are ignored so that only accurate blocks of data are processed. If valid data is not received by either end for more than one second, the link alarm output is asserted at both ends.

A failure of the transmitter to studio link (TSL) means that the values displayed on the studio until will not be current. The studio display will flash until the link has been restored. During a failure of this link, old data may still be read on all channels and the status and mode indicators will show the last available information.

If the studio to transmitter link (STL) remains good during a TSL failure, control is still possible although there will be no way of directly reading the effects of any changes made.

A failure of the STL means that the control is no longer possible and a 45 second fail-safe timer begins. If valid data is not received in 45 seconds, the fail-safe output turns off. The failsafe is restored promptly on receipt of valid data at the transmitter. An STL failure will not affect readings at the studio unit so the display does not flash.

Fail-safe may be overridden (forced on) at the transmitter by entering the maintenance mode.

Power Failure Recovery

A power failure at the transmitter will drop all outputs including fail-safe immediately. When power is restored, the unit will return to normal operation within two or three seconds. The display will come up on channel one with all status and calibration constants restored to their previous value. If the system was in the maintenance mode at the time of power failure, the system will return to the maintenance mode. Otherwise normal mode is restored. All channels on the studio unit will be immediately updated and both link alarms will clear provided that the links are still good. Fail-safe will be restored as soon as valid data from the studio has been confirmed.

A power failure at the studio will cause a link alarm at the transmitter and begin the 45 second fail-safe timeout. When studio power is restored, channel one data will be displayed and operation will resume normally.

SECTION THREE

INSTALLATION

Before installation, it is recommended that the operation of the TC-8 is thoroughly understood and that a brief checkout be performed with both units at the same location. It is also desirable to have the plant interconnections fully documented and all wiring in place before beginning the installation.

Unpacking

The studio and transmitter units are packed separately in cartons designed specifically for the TC-8. The location and orientation of the cushioning material should be noted and the material saved in case it is necessary to reship the unit.

Check both cartons to see that you have one studio unit and one transmitter unit with the proper options indicated on the side panel. If the interface panel option has been ordered, it will be packed in a separate carton.

Carefully unpack both units and inspect for shipping damage. If damage is detected, immediately file a claim with the freight carrier. They will usually send an inspector to fill out a report and will want to see the packing materials as well.

Each carton should contain the following items:

Studio or transmitter unit
Power cord
Instruction manual
Mating I/O connectors (transmitter unit only)

==========

CAUTION

NEVER REMOVE THE COVER WITHOUT FIRST UNPLUGGING THE UNIT.

==========

There are no internal adjustments normally required before installing the system but it may be desirable to remove the top cover from each unit to be certain that there is no concealed shipping damage. In particular, the power transformer should be tightly secured to the chassis and all

socketed IC's and interconnect cables should be firmly seated in the sockets. The plug-on jumper on the modem boards should be in the opposite position in the two units. Only the transmitter unit has a 2817A installed on the CPU board. The studio unit will have an empty socket at that location.

Unless otherwise requested and so marked, the TC-8 is shipped for operation at 115V nominal. This may be confirmed by observing the transformer primary connections on the output terminals of the power entry module. Connections for both 115V and 230V operation are shown in table 3-1.

Note: When replacing the top cover, be sure to place the short screw in the front center hole.

Primary Power Connections

	115v	230v
Terminal 1	Blue Violet	Blue
Terminal 2	Grey Brown	Brown
Jumper	---	Violet Grey
Fuse	AGC 1/2	AGC 1/4

Table 3-1. Terminals 1 and 2 refer to the load side connections of the power entry module. Colors refer to the primary leads of the power transformer.

Functional System Checkout

Place both units in a convenient location near each other and connect the communications links as appropriate for the type of modems installed. If wire modems are installed, connect the barrier strip terminals marked "Line" from one unit to the other, separated by a 20 dB 600 ohm pad. The pad simulates the loss of a normal wire link and prevents overdriving the receive input.

If radio modems are installed, use BNC cables to connect "Radio In" to "Radio Out" and vice versa.

Apply power to both units. The front panel indicators on both units should read as follows:

Status:	Same for both units
Channel:	1
Value:	0000 or -000
Maint:	Same for both units
Setup:	Off
Calib:	Off

If the studio display is flashing, recheck the modem connections or refer to the troubleshooting section if necessary.

Press the channel select switch on either unit and verify that the channel advances to the next digit. When channel eight is reached, the display will advance to channel one. The display on the opposite unit will not change.

Enter the setup mode on the transmitter unit. Pressing the "raise" switch will cause the status input corresponding to the channel number to change from off to on or vice versa. Verify that this change is displayed on both units. Pressing the "lower" switch will cause the decimal point to shift one position to the left. This change will only be observed on the studio unit when the appropriate channel is selected.

Refer to figure 3-1 and table 3-2 and connect a 1.5 volt battery or other voltage source to one of the analog inputs. Select the appropriate channel on the transmitter unit. The display may or may not indicate a value, depending on the last calibration of the channel. Press the calibrate switch and use the raise and lower switches to adjust the displayed value to some convenient number. Exit the calibrate mode by pressing the calibrate switch again. The studio unit should now indicate the same value when that channel is selected.

Refer to figure 3-1 and table 3-2 and short one of the status inputs to ground. Both units should display the change in status.

Refer to figure 3-2 and table 3-2 and connect a lamp, LED, or relay to one of the raise outputs. Figure 3-4 shows several ways to connect various devices to the open collector outputs. The external device should be off until the appropriate channel is selected and the raise switch is pressed. Verify that the output is asserted from the studio only when the system is not in the maintenance mode. Also note that the raise and lower switches at the transmitter do not cause an output while in the setup or calibrate modes but that the studio unit can still be used for control.

If the outputs do not function properly when the command is given from the transmitter, recheck the connections and refer to the troubleshooting section if necessary. If the outputs function from the transmitter unit but not the studio unit, the link from the studio may not be valid. Recheck the modem connections and refer to the troubleshooting section if necessary.

Connect indicators to the alarm and fail-safe outputs, referring to figures 3-2 and 3-3 and table 3-2. The alarm outputs should be off and the fail-safe should be on. Now interrupt the the link by disconnecting one of the barrier strip connections (wire modems) or BNC connectors (radio modems). Any link failure should cause the alarms to turn on after approximately one second. Wait about 45 seconds and observe that the fail-safe output turns off. Press the maintenance switch and observe that the failsafe output turns on. Restore the link and observe that the alarms both clear.

If radio modems are being used, you can observe operation with only one link active. With the STL path good you should still be able to execute commands from the studio but the display will be flashing indicating that the data is not current. With the TSL path good you will have no control and the fail-safe will time out but you will still be able to take readings.

This completes the basic system check out. You should now be familiar with the operation of the unit.

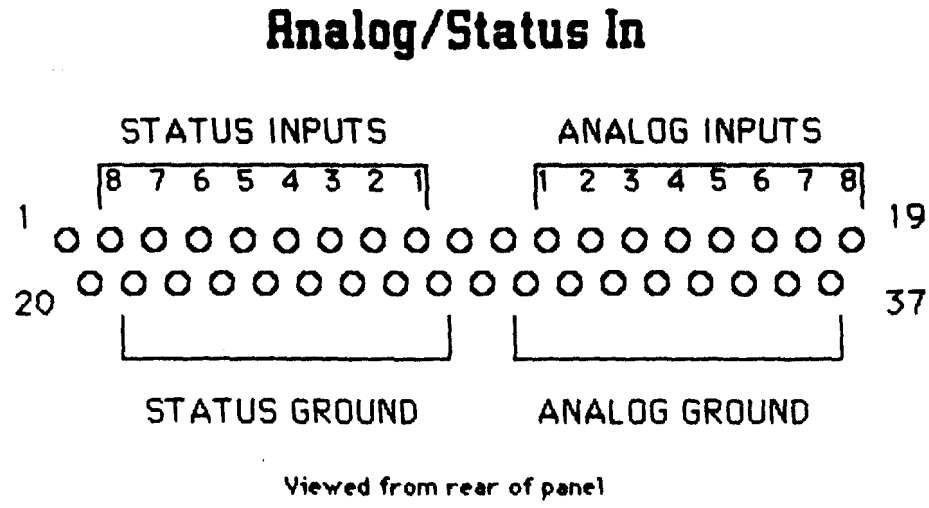


figure 3-1. Rear panel Analog/Status Input Connections.

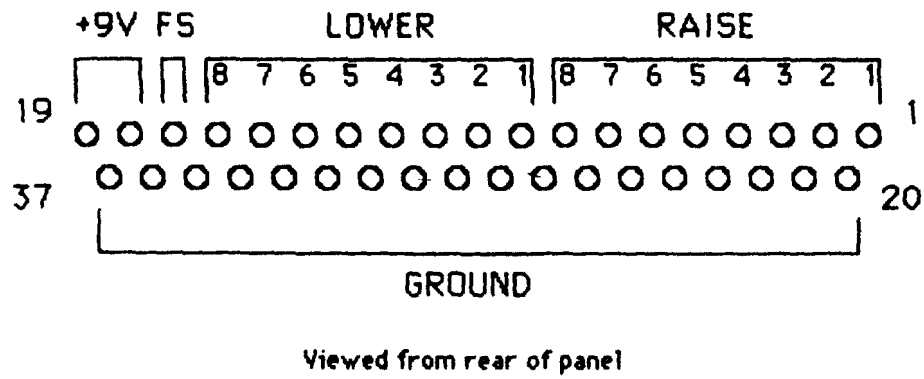


figure 3-2. Rear panel Control Output Connections.

ANALOG/STATUS INPUTS

Pin	Function
1	3.3k pullup to +5
2	Status #8 +
3	Status #7 +
4	Status #6 +
5	Status #5 +
6	Status #4 +
7	Status #3 +
8	Status #2 +
9	Status #1 +
10	Status Ground
11	Analog Ground
12	Analog Channel 1
13	Analog Channel 2
14	Analog Channel 3
15	Analog Channel 4
16	Analog Channel 5
17	Analog Channel 6
18	Analog Channel 7
19	Analog Channel 8
20	Status Ground
21	Status #8 Ground
22	Status #7 Ground
23	Status #6 Ground
24	Status #5 Ground
25	Status #4 Ground
26	Status #3 Ground
27	Status #2 Ground
28	Status #1 Ground
29	Analog Ground
30	Analog #1 Ground
31	Analog #2 Ground
32	Analog #3 Ground
33	Analog #4 Ground
34	Analog #5 Ground
35	Analog #6 Ground
36	Analog #7 Ground
37	Analog #8 Ground

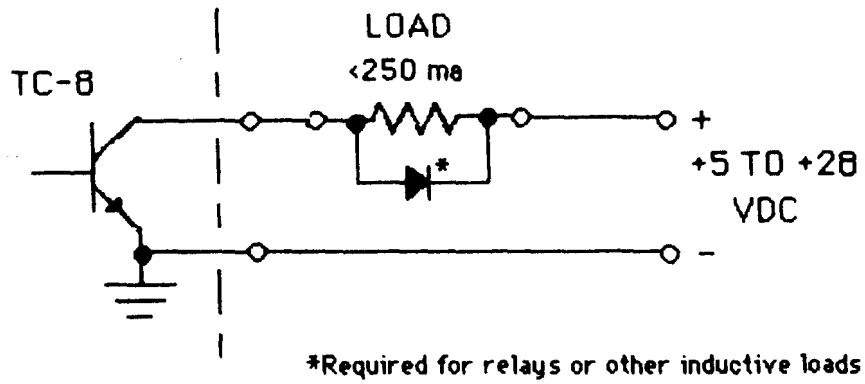
CONTROL OUTPUTS

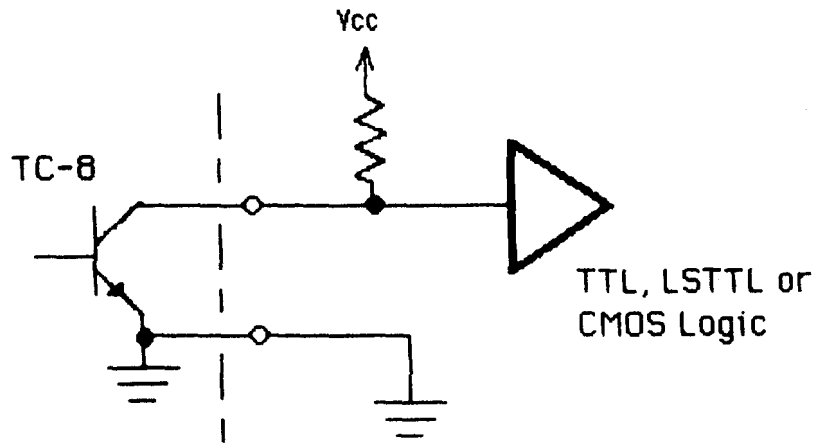
Pin	Function
1	Channel 1 Raise
2	Channel 2 Raise
3	Channel 3 Raise
4	Channel 4 Raise
5	Channel 5 Raise
6	Channel 6 Raise
7	Channel 7 Raise
8	Channel 8 Raise
9	Channel 1 Lower
10	Channel 2 Lower
11	Channel 3 Lower
12	Channel 4 Lower
13	Channel 5 Lower
14	Channel 6 Lower
15	Channel 7 Lower
16	Channel 8 Lower
17	Fail-safe
18	+9vdc unregulated
19	+9vdc unregulated
20	Channel 1R Ground
21	Channel 2R Ground
22	Channel 3R Ground
23	Channel 4R Ground
24	Channel 5R Ground
25	Channel 6R Ground
26	Channel 7R Ground
27	Channel 8R Ground
28	Channel 1L Ground
29	Channel 2L Ground
30	Channel 3L Ground
31	Channel 4L Ground
32	Channel 5L Ground
33	Channel 6L Ground
34	Channel 7L Ground
35	Channel 8L Ground
36	Power Ground
37	Power Ground

table 3-2. I/O Connector Pinouts

Pin	Label	Function
1	Alarm +	Link Alarm Open Collector
2	Alarm -	Link Alarm Ground
3		No Connection
4	Line	600 ohm Balanced Link I/O
5	Line	" "
6	GND	Link Protective Ground

figure 3-3. Rear Panel Barrier Strip Connections.





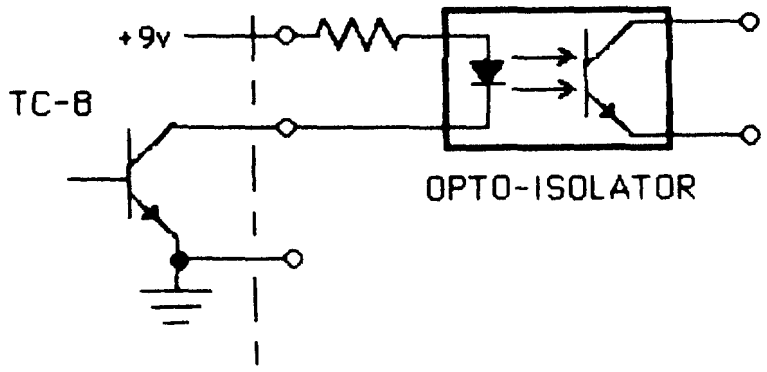


figure 3-4. Output Connections to External Devices.

Installation Considerations

Before installing the TC-8, it is wise to plan the channel assignments and control configuration carefully. If you are replacing an older unit it might also be a good time to clean up some of the transmitter plant wiring to improve the overall reliability of the system.

Control Outputs

The outputs from the TC-8 are rugged and nearly bullet-proof but care should still be used to make certain that the outputs are operated within a safe current area. Reasonable overcurrent will not damage the outputs but will prevent them from properly driving the load until the load is reduced to a proper level.

Transmitters and associated equipment use various voltages for remote control operation. Some modern transmitters use 12 or 24 volts DC and may be directly interfaced to the TC-8. If the control circuits operate on more than 28 volts or require AC, it will be necessary to interface the TC-8 with external relays. The optional interface panel is suitable for this and allows direct connection of AC or DC switching contacts. Note that high-current switching loads (greater than about .5 amps) should still use slave relays of adequate rating.

If 110 volt control circuits are used, do not leave the contacts exposed where someone (maybe you!) might accidentally discover their full potential. For this reason we find it highly desirable to use low voltage DC for control with slave relays mounted within the equipment cabinets where necessary.

For the remainder of this discussion we will assume that all outputs will drive DC loads of 28 volts or less and that the required slave relays are installed within the equipment as necessary. DC power supplies used to provide the operate voltage should be limited to some reasonable size for safety and reliability. A 2-amp regulated supply of 12 or 24 volts is plenty of power for almost any plant and will not turn into an arc welder if a cable is shorted.

To use the open collector outputs it is necessary to provide a proper source of voltage to the controlled device and bring the ground side of the device to the TC-8 output. This is commonly referred to as "ground operate" as the open collector output provides the required ground when the command is executed. Of course you must also provide a ground return to the power supply. Please observe the polarity on

all outputs. The output voltage must be above ground for the output to work. Figure 3-4 shows several possible configurations. The ground for all outputs is common but at least one ground return should be provided to each external unit. Do not depend on station ground for this as ground loops will surely result. It is not necessary to run control circuits in shielded cable.

All outputs with the exception of the fail-safe are momentary and are normally off. In some cases it may be necessary to provide a latched output or a normally on output. This can either be accomplished by using external relays or external logic. Latching relays are available as mechanical latches or as magnetic latches that hold with remanent magnetism. They are typically operated by connecting the "raise" output to one coil (on) and the "lower" output to the other coil (off).

If it is decided to use external logic, TTL, LS-TTL or CMOS devices may be operated directly from the TC-8 outputs (with pull-ups where required). This will allow flip-flops, gates and external status signals to be integrated into the control system as dictated by the unique plant requirements. Relays may then be driven where necessary using transistor drivers or opto-isolators. Up to 200 ma of unregulated DC voltage may be taken from the control output connector as indicated. This may be used to provide Vcc for the external logic using a five volt three-terminal regulator on the external logic board.

Analog Inputs

Most transmitters provide remote metering outputs which provide a sample voltage within the acceptable range. In some cases it will be necessary to convert the signal to a DC sample or perhaps install a voltage divider to bring the sample within range. Some equipment produces extremely low output samples and it may be desirable to install an instrumentation amplifier to improve the accuracy of the sample. The TC-8 will meet specs with an input as low as 250 mv which is adequate for most equipment including several popular reflectometers which produce notoriously low sample voltages. As a general rule, the sample should be pre-scaled to provide four volts for the highest expected value. This will provide maximum resolution and accuracy. Burk Technology will provide telephone assistance to customers having difficulty.

Connect the desired sample voltages to the analog inputs as indicated in figure 3-1 and table 3-2. Each sample should be brought to the TC-8 in a shielded cable to reduce noise on the sample. All analog inputs have a common ground but again it is important to provide the best possible ground return for each sample. In extremely noisy environments it may be necessary to carry the signal ground as a separate conductor in a shielded cable with the shield tied to chassis ground at only one end.

Where the station operates at more than one power level with the same transmitter it is often difficult to achieve accurate samples over the entire range. This is due to poor tracking of the sample voltage as opposed to any limitation in the TC-8. The simplest solution is to connect the same sample to two TC-8 inputs and calibrate one for each mode. This limits the tracking requirements to about ten percent of the range instead of the entire difference from high to low power. Where the additional channels are not available it may be necessary to use external correction amplifiers which have adjustable slope and intercept.

Status Inputs

The status inputs are provided with internal pull-up resistors so that they may be used with switch closures or active outputs. The minimum acceptable signal is an LS TTL output. The input has a fan-in of one unit load. The highest acceptable signal is 28 vdc. Hysteresis is provided on all status inputs to improve noise immunity. Care should still be exercised to assure a good, direct ground return for each input and to make certain that the source comes as close to ground as possible for an off indication. The inputs will accept a negative signal of up to -28 volts without damage which will be interpreted as an off.

Where switch closures are used, the inputs are relatively immune to bounce but the switch contacts must provide a good low resistance path to assure reliable operation. Switch closures are connected directly from ground to the status input. Again, use a separate, dedicated ground return for each piece of equipment.

Fail-safe Output

The fail-safe output remains on as long as there is valid data arriving from the studio. This output is frequently used to control the filament circuit of the transmitter although it may be integrated into the control system

in a different manner. It is an open collector output with exactly the same characteristics and over-current protection as the raise and lower outputs.

Alarm Outputs

The alarm outputs are identical on the studio and transmitter units and provide indication of link loss in either direction. These are low-current open collector outputs and must not be connected to loads greater than 50 ma. The alarms may consist of lights, buzzers or other appropriate signals and may be muted by the studio mic switch if necessary. Use interface techniques similar to those shown in figure 3-4. It is highly recommended that these signals be connected and used as they will provide an early indication of possible link problems.

Connection to AM Antenna Monitors

To provide remote monitoring of phase and current in a directional array, it is necessary to provide some means of switching from the reference tower to the other towers. A simple solution is to bring the phase to one input and the current to another and use the raise and lower outputs in parallel to provide selection of up to three towers. Typically, the off condition is used to select the reference tower while raise and lower select two additional towers.

If four or more towers are used, the raise outputs may be used to advance to the next tower with status inputs used to display the selected tower. Up to eight towers may be monitored this way using three status inputs, one output, and two analog inputs. Burk Technology will provide telephone assistance and representative schematics on request.

Selection of Links

The selection of suitable STL and TSL circuits will be controlled by cost and availability of voice-grade phone lines, availability of 450 MHz or 950 MHz spectrum, cost of RF equipment and the existence of a line of sight path to the transmitter. Each plant will have different requirements and available options. Redundancy and reliability should be considered when choosing the type of links to use.

By far the simplest type of link is a common voice-grade phone line. The wire modems supplied in the TC-8 utilize standard Bell 103 tones and will work well over almost any 2-wire telephone circuit that will pass voice frequencies. If for any reason it is necessary to use 4-wire telephone circuits, contact Burk Technology for information on converting the modems to 4-wire. The telephone line is connected to the barrier strip terminals marked "Line" on the rear panel of both units.

Where telephone circuits are not available or desireable, radio modems may be used which provide a subcarrier for use with 950 MHz STL transmitters for STL and an FM subcarrier for the TSL. A 450 MHz TRL transmitter may also be used for the TSL. Connection is the same but the transmitter to studio signal is baseband audio. Make certain that the studio and transmitter units are equipped with modems on the desired frequency before connecting the BNC inputs and outputs to the STL transmitter or exciter.

SECTION FOUR

TECHNICAL DESCRIPTION

The TC-8 remote control system consists of four basic modules in the transmitter unit and three similar modules in the studio unit. A description of each module will follow a brief overview of the system.

Both studio and transmitter units are microprocessor based. All displays and outputs are derived from the microprocessor (MPU). Analog input voltages are converted to a 12 bit binary value by the analog to digital converter, then multiplied by a calibration constant and converted to a decimal number by the MPU. Status inputs are conditioned and read by the MPU and converted to the proper polarity. All raise, lower and alarm outputs and the fail-safe output are driven under the control of the MPU. All switches and displays are also connected to the MPU. A watchdog timer gets periodically retriggered by the program and forces a master reset if the program fails for any reason. Communications with the studio is via an appropriate modem which converts FSK signals to digital levels. The modem connects to an asynchronous communications interface adapter (ACIA) which converts the incoming serial data into parallel so it can be read by the MPU and similarly converts MPU data into serial form for transmission by the modem.

The MPU, memory, ACIA and power supply are all located on the CPU board located near the front of the chassis. The A/D converter, input conditioning and output drivers are located on the I/O board which is at the rear of the chassis on the transmitter unit. This board connects to the CPU board via a 24 pin header. All displays and switches are located on the display board immediately behind the front panel. The modem board, located in the rear near the center contains the modem, protective circuitry for the line connection and the alarm output.

I/O Board

This board is unique to the transmitter unit and contains analog input, status input and control and fail-safe outputs.

Each analog input channel is filtered and sent to a CD4051 eight input analog multiplexer. The multiplexer receives channel select commands from the MPU via a 74LS175 latch and puts the proper channel into the input of the

ICL7109 A/D converter (ADC). Negative voltage for the multiplexer and the ADC is obtained from an ICL7660 DC to DC converter.

The ADC is a dual-slope integrator which compares the input voltage with a very stable reference voltage from an LM399. The 12 bits plus sign and overrange are read by the MPU whenever the ADC signals via an interrupt that a conversion has been completed. The next channel to be read is latched into the multiplexer and another conversion is begun immediately. The program controls the sequence of channels to be read and is designed to maximize the update rate for the channels being displayed by the studio and transmitter units but still reads all channels periodically.

The crystal frequency and clock divider ratio for the ADC are chosen to provide rejection to 60 Hz components on the incoming samples. This coupled with effective input RF filtering provides a very quiet signal for the ADC.

Status inputs are connected to two MC1489 quad line receivers. These inputs are filtered and have a pull-up to five volts. The MC1489 provides hysteresis to provide noise immunity. The MC1489 outputs are put on the bus at the proper time by a 74LS244 buffer. The program scans these inputs once every few milliseconds, exclusive ORs the status with a mask to selectively invert polarity, and displays the result.

Seventeen outputs are provided on the I/O board, eight raise, eight lower, and fail-safe. These outputs are latched by the program into two 74LS259 addressable latches (raise and lower) and bit 3 of the 74LS175 (fail-safe). Each output drives a ULN2003 Darlington transistor output. A small current sample is taken from collector and is measured by a 2N3905 PNP transistor. When the current exceeds the maximum allowed, the PNP turns on, switching another ULN2003 which forces the output off. The output will attempt to cycle on repeatedly and will return to the on condition as soon as the overload is removed.

Modem Board

The modem boards consist of an MC14412 Bell 103 modem, an MC145440 switched capacitor filter and an LM339 voltage comparator. On wire modem boards, the input and output are combined in a duplexer implemented with an uncommitted op amp in the MC14412 and connected to a 600 to 600 ohm transformer for connection with the line. The line connections are protected from transients by a network of capacitors, zener diodes and a metal-oxide varistor and brought to the barrier strip on the rear panel.

Radio modems apply the AFSK signal from the modem to the FM input of an XR2206 function generator to produce a modulated subcarrier. An XR2211 decoder is used to demodulate the incoming subcarrier and supply the modem with an AFSK signal. The subcarrier input and output appear on BNC connectors on the rear panel. For use with a TRL transmitter the baseband AFSK appears on the output BNC. The modem will be marked "0 kHz out" to imply baseband output.

Each modem board contains a three pin header with a plug-on jumper which is used to select answer or originate modes for each modem. The studio modem is operated in the answer mode (2025 Hz and 2225 Hz transmit) and the transmitter modem is operated in the originate mode (1070 Hz and 1270 Hz transmit). The jumper is installed on pins 1 and 2 (right-most when viewed from front of unit) for transmitter units and pins 2 and 3 (left-most) for studio units.

The modem board also contains a 74LS123 retriggerable one-shot which is triggered by the MPU whenever good data is received from the link. The output drives a 2N3903 NPN transistor which provides an open collector output to the barrier strip to drive a link alarm. The one-shot times out one second after receipt of the last valid block of data from the link. The program also checks for acknowledgement from the other unit that valid data is being received at that end. If acknowledgement is not received, the retrigger pulse is inhibited also allowing the one-shot to time out. Since the one-shot requires periodic pulses from the program, the alarm will also be asserted if the unit experiences a catastrophic failure.

Display Board

Five HP5082-7300 Dot Matrix Arrays on the display board accept data from the MPU and latch, store and display the data. A 74LS138 selects the proper display. Two 74LS259's latch data from the bus into the eleven LED indicators. The six switches are taken directly to the CPU board.

CPU Board

An MC6802 8-bit microprocessor on the CPU board executes the program stored in a 2764A 64k bit EPROM. Temporary storage is provided by random access memory internal to the MC6802. Non-volatile storage of calibration constants and setup data is provided by a 2817A EEPROM (transmitter unit only). A 74LS244 is used to buffer the data bus to the display board while a second 74LS244 buffers the front panel

switch inputs. Two 74LS138's provide partial address decoding for all sub systems.

An MC6850 Asynchronous Communications Interface Adapter handles the data conversion for the modem. The baud rate clock for the MC6850 is obtained by dividing down the 1 MHz E signal from the MPU with a 74LS161 and a CD4024 to 16 times the baud rate. A jumper is permanently installed on the CD4024 output to select 300 baud.

A 74LS123 dual one-shot forms the watchdog timer which drives the master reset. The program drives the first timer through a differentiator. If the program ceases to retrigger this timer, it times out in about 500 ms. The output from this timer then triggers the second timer which provides a 10 ms pulse to the reset circuit. This output is fed back to the first timer to force repeated reset attempts until the program takes over and operates properly.

The CPU board contains one additional site for memory expansion.

Power Supply

Incoming AC is fused in the power entry module and fed to an EMI filter to reduce susceptibility to RF noise on the power line and also to reduce the radiation of signals generated by the internal clocks. The power is then fed to a toroidal power transformer which produces 9 volts RMS. The secondary is connected to the power supply rectifier, filter, and regulators on the CPU board. One UGH7805 regulator provides 5 volts to the display board while a second provides 5 volts to the remaining subsystems. Unregulated DC is also provided to the I/O board to provide a source for the precision reference. This voltage is also made available on the rear panel to power external logic or the optional relay interface panel.

SECTION FIVE

TROUBLESHOOTING

The TC-8 is built using highly reliable components and conservative circuit design. Many years of trouble-free operation can be expected without any routine maintenance other than occasional cleaning of the front panel with a mild detergent.

The procedures that follow may require skills or test equipment not available at the station. Proceed only as far as you can without risking possible further damage, then call the factory.

Power Supply Problems

If nothing lights on the front panel the most likely cause is a power supply failure. The fuse may be checked by unplugging the unit and removing the rectangular insert on the rear of the power entry module. Check the fuse visually or with an ohm meter and replace if necessary with a fuse of the proper rating (AGC .5 amp for 115 volt units). Never defeat the fuse protection.

If the fuse continues to blow, the most likely cause is a short in one of the power supply components or across the unregulated buss. Remove the I/O connectors. If the unit lights up with the connectors removed, look for a short or a high current load on the unregulated output pin of the Control Out connector. It is also possible that the mating connector has been miswired.

Visually inspect the rectifier diodes and check with an ohm meter if they look like they've been "cooked". Before replacing a shorted diode, try to determine the cause of the high current condition. Unplug the ribbon cables going to the modem and I/O boards to isolate the board containing the short. If the problem is isolated to the modem or I/O board, look for a solder bridge or loose piece of wire causing a short. A short in the ICL7660 or associated components on the I/O board could also be the cause. If the

fuse continues to blow with only the CPU and display boards connected, there is probably a short in one of the power supply components. Check the rectifier diodes, filter capacitors and regulators in that order.

If the fuse is OK but the display is still dark, check that 5 volts +/- .25 volts is present at the output of both 7805 regulators. Exercise caution near the regulator heat sink as it normally runs hot to the touch. If no voltage is present at this point, check for approximately 9 volts across one of the large electrolytic capacitors and approximately 9 volts rms between the anodes of the rectifier diodes. If DC is present on the input of the regulators but not on the output, replace the regulator. If AC is present but DC is not, suspect the diodes. If there is no AC on the diode anodes, check the power connector on the CPU board for an unseated wire. Unplug the power connector and check for AC from the transformer. If AC is present, remove the CPU board from the chassis and check for an open trace or defective solder connection. If no AC is present on the connector, the problem is isolated to the connector, power transformer, power entry module, or line cord.

I/O Problems

If an output does not function properly, first check the external connections. If other outputs work, move the load to another output to confirm that the external load and connections are proper. Once the problem is isolated to the I/O board, compare readings of the associated ULN2003's and 2N3903 with other functioning channels and locate the defective component by substitution.

If no output functions, the problem may be on the I/O board or CPU board.

Status input problems are most likely related to the connector or one of the MC1489's. If inputs 1-4 or 5-8 are all bad, replace the associated MC1489. A single bad input is possibly the result of a bent pin on the connector.

Analog input problems may be due to destruction of the input multiplexer by excessive voltage at the input, connector problems, or a failure on the CPU or I/O board. Once the connector and other obvious possibilities have been eliminated, it will be necessary to check operation of the multiplexer. With at least one input connected, check for a periodic voltage on the output of the CD4051. The channels are scanned fast enough that an oscilloscope will be necessary to obtain useful information. It is also possible to remove the 499K resistor and insert a voltage directly into the ICL7109 ADC. Note that you will still obtain different

readings on each channel as the calibration constant is most like different on each one.

Both the CD4051 and the ICL7109 require -5 volts for proper operation. Check the output of the ICL7660 for -5 volts +/- .25v.

Pin 2 of the ICL7109 should change state periodically, indicating the completion of a conversion. If it does not, suspect the chip, crystal or capacitors.

CPU Problems

Improper or erratic operation may be due to a problem on the CPU board. This should be considered if one unit works properly but the other operates abnormally.

The 2817A may be removed from the transmitter unit without affecting the operation of the unit except that the analog values will no longer be correct and the setup information (decimal point and status polarity) will not be normal. If the transmitter unit runs with the chip removed but is erratic or doesn't run with it installed, replace the 2817A.

The 2764A PROM's may also be swapped if a problem is suspected. Data will not be valid and the units will not communicate, but it should still be possible to rotate through the eight channels with the opposite PROM installed. If the PROM is believed to be defective, it must be replaced with a factory programmed part.

Display Problems

The display boards are identical in both units and may be swapped to confirm a problem. Be certain to orient both ribbon connectors exactly as they were. Improper switch operation may be confirmed by observing the closures to ground on the 15 pin connector.

Modem Problems

Before suspecting a modem problem, check the link. If the link appears satisfactory, put both units at the same location and connect the line terminals together with a 20 dB pad. (Wire modems only.) The pad is very important as